EXCITATION OF TERAHERTZ 2D-PLASMON MODES IN A GRAPHENE RIBBON ARRAY

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A graphene ribbon array (GRA) is a novel structure that can hold various types of two-dimensional plasmons (2DPs) of graphene. Due to the unusual electronic dispersions of graphene, the fundamental plasmon frequency easily falls in the terahertz (THz) region even for a ribbon width > 10 μm. We observed THz 2DPs in an optically-pumped GRA by using terahertz time-domain spectroscopy.

A GRA sample having a 50-μm ribbon width and space was prepared from an exfoliated graphene on a SiO_2/Si substrate. The sample was optically pumped by an 80-fs, 1550-nm, 2-mW pulsed fiber laser with a 20-MHz repetition rate with polarization parallel to the ribbon direction. Then a THz probe pulse was impinged onto the sample 3.5 ps after each pulsed pumping. The temporal response of the THz probe pulse transmitted through the sample was electro-optically detected using a CdTe sensor crystal. The photogenerated electrons/holes relax their energy by emitting optical phonons, accumulating around the Dirac point, resulting in population inversion in 10s of ps duration after pumping. When the pumping intensity is below the threshold, the THz dynamic conductivity retains in positive so that the 2DPs exhibit distinctive resonant absorption spectra during the energy relaxation of photocarriers. In conclusion, as is expected, the GRA exhibits clear absorption peaks corresponding to the 2DP modes with the fundamental mode as high as 450 GHz even for a wide ribbon width of 50 μm, demonstrating superior electron transport properties in graphene.

Furthermore, we also measured THz absorption in another GRA sample having a 6-μm graphene ribbon width and 14-μm empty space on a 6H-SiC substrate. THz radiation was generated from a ZnTe crystal excited by an 800-nm, 800-mW mode-locked Ti:Sapphire laser with a 80-MHz repetition rate. The transmitted THz radiation was detected by a photoconductive antenna. Polarization and frequency dependence of THz transmission will be discussed.